

triously and ably worked out, and, on the whole, well written. At the same time, it should be pointed out that such a work was especially in need of a good and exhaustive index, and that it is a pity the author did not compile one himself.

#### CALCULATION BY ABACUS.

*Traité de Nomographie.* Par Maurice d'Ocagne. Pp. xiv + 480. (Paris : Gauthier-Villars, 1899.)

THIS is a book which ought to make even the ordinary reader appreciate the perennial freshness of mathematics. The method of "Nomography" (X3 of the international catalogue), recent as it is in its more important developments, is based upon a very simple idea which has long been familiar—that of the indexed scale. The ever-recurring problem of applied mathematics is to calculate an unknown numerical quantity from its relation to other quantities that are known. The simplest case is when two quantities  $x, y$  are connected by a relation  $f(x, y)=0$  or  $y=\phi(x)$ . For practical purposes it is convenient to have a permanent record of a large number of corresponding values of  $x$  and  $y$  so that for any given value of  $x$  the approximate value of  $y$  may be at once found or obtained by simple interpolation. Three methods are available: the first is that of a numerical table, such as a table of logarithms; the second that of the graph, for instance the curve  $f(x, y)=0$  or  $y=\phi(x)$  referred to rectangular coordinates; the third is that of the indexed scale, that is to say a straight line or curve at different points of which the corresponding values of  $x$  and  $y$  are shown in figures. A familiar example is given by a thermometer with Centigrade and Fahrenheit readings, or by a measuring tape with centimetres marked along one edge and inches along the other.

In this very simple case the advantage of the indexed scale is not very obvious; even here, however, the method combines much of the vividness of the graph with a considerable saving of space. It is when three or more variables are connected by a relation that the great value of the scale method becomes apparent. Suppose, for instance, we have a relation

$$F\{\phi(x), \chi(y), \psi(z), \omega(t)\}=0$$

where  $x, y, z, t$  are the variables and  $F, \phi, \chi, \psi, \omega$  are known functions. The essence of the nomographic function consists in first plotting off in a suitable way indexed scales of  $\phi(x), \chi(y), \psi(z), \omega(t)$ , and then employing a linkage or similar mechanism to associate four corresponding values,  $x', y', z', t'$ . In the case of two variables  $x, y$  the "linkage" consists merely in the juxtaposition of the scales; when a proportion sum is done with a slide-rule, the scales are moved relatively to each other; in most of M. d'Ocagne's illustrations, involving several variables, the scales are either superposed in a two-dimensional grating or a movable linkage is used consisting of a transparent sheet with lines of reference ruled upon it, or a combination of both devices is employed.

Of course a method so elastic leaves ample room for ingenuity in constructing an "abacus," as M. d'Ocagne calls it, suited to any particular problem. The author

gives an abundant variety of illustrations, many of great practical importance to the physicist and engineer: it is by studying these, and actually taking readings for himself, that the reader will succeed in appreciating the value of the method. For of this, as of other graphical methods, it may be said that merely reading it up, or understanding its principles in a general way, is of little use as compared with a thorough working knowledge of its application.

At the same time, M. d'Ocagne has done really good service in devoting his final chapter to the general theory. This has, in its way, the same kind of special value as Reuleaux's "Kinematics of Machinery" in relation to the ordinary treatises on mechanism. For in this chapter we have a clear conspectus of the general principles which underlie the construction of *any* abacus; and, what is still more remarkable, all possible varieties of abacus are classified into perfectly definite types which can be expressed by a simple abstract notation. Oddly enough, the enumeration of the different types leads to a difficult problem in the partition of numbers, happily solved by Major MacMahon.

It is not impossible that the human race may ultimately set off against the ravages of warfare the indirect stimulus which it has given to mathematics; nomography, at any rate, has been developed in great measure to meet the demands of civil and military engineering. M. d'Ocagne's numerous bibliographical notes will enable his readers to follow in detail, if they wish, the history of the subject. Pure and applied mathematicians alike will be grateful to him for a work so full of novelty and interest; while its subject-matter, as well as its clearness and simplicity, ought to make it eminently acceptable to the engineer.

G. B. M.

#### OUR BOOK SHELF.

*Die Spiele der Menschen.* By Karl Groos. Pp. vi + 538. (Jena : G. Fischer, 1899.)

PROF. GROOS will add by the present volume to the reputation he has already earned by his well-known work on the "Games of Animals." A really comprehensive account, at once sympathetic and intelligent, of the games of both children and adults has long been a desideratum with the psychologist as well as with the anthropologist, and Prof. Groos's new work goes very far indeed towards permanently supplying the want. As is only right and proper, by far the larger part of the book is given up to an exhaustive description of the facts as far as they are known; the "Theory of Play" enunciated in the second part of the treatise can thus be judged by the reader upon a sufficiently wide basis of empirical information. The range and the accuracy of Prof. Groos's knowledge are alike surprising; not only is he a mine of information about the amusements of his own country, but he appears, for instance, as much at home in the English nursery and playground as though he had been brought up amongst us. Almost the only signs of imperfect knowledge of English games to be detected in the whole book are the author's ascription of "Hare and Hounds," in its familiar form, exclusively to America, and his apparent ignorance of the continued vitality of "Hunt the Slipper." As a psychologist Prof. Groos is distinguished by a singular subtlety of discrimination; his account, for instance, of the various elements which enter into the gambler's enjoyment of high play, or, again

of the combination of "the pleasure of intense stimulus" and the "pleasure of conflict" in our enjoyment of a tragedy, are models of delicate æsthetic analysis. The author's attitude towards the various current theories of "play" is eminently judicious. As he well points out, both the "surplus activity" theory and the "recreation" theory are one-sided, the former doing less than justice to the pastimes of adults, the latter to those of children. His own view that play must be regarded by the biologist primarily as the great educator and perfecter of imperfect instincts has been most nearly approached by Prof. Baldwin. Prof. Groos's treatment of the sociological aspects of "play," both as the child's earliest form of experimentation and as the earliest school of obedience to authority, should prove useful to students of ethics as well as to professed sociologists. The admirable literary style of the book, no less than the interest of its contents, should recommend it to all persons of general culture who care for anthropological studies.

A. E. T.

*Physique et Chimie Viticoles.* By A. de Saporta. Pp. iv + 300. (Paris: G. Carré and C. Naud, 1899)

In the preface to this book, contributed by M. P. P. Dehéran, the immense importance of the vine culture to France is pointed out, the wine from the department of Hérault alone having in 1897 a value of 212,000,000 francs. The questions of suitability of soil, of manures, of the remedies against the many diseases of the vine, of fermentation, and preservation of wine all depend largely upon simple chemical and physical considerations; hence arises the necessity for such a work as the present, dealing with the physics and chemistry of vine culture and wine production. Of the eight chapters composing the book, the first two are preliminary, giving a very brief outline of the atomic theory and the measuring instruments used in the laboratory. The third chapter deals with the soil, especial attention being directed to the use of various insecticides, and to the causes of vine disease generally residing in the soil. In the third chapter, on account of the importance of the estimation of calcium carbonate in the soil, numerous calcimeters are described, some of considerable and apparently unnecessary complexity, as, for example, the self-registering calcimeter of Houdaille. The description of the properties of manures is lucid, and their analysis is treated in a simple manner. Chapter vi., dealing with the remedies for vine diseases, is, on account of the evident practical knowledge of the author, the most valuable portion of the book. The number of remedies that have been invoked to combat mildew, black rot, chlorosis, phylloxera, and other vine diseases, is so great as to render their classification and intelligent use difficult. Especial attention is here directed to the use of carbon bisulphide, ferrous sulphate, sulphur, copper sulphate and acetate, and mercury salts, the last-named being emphatically condemned in spite of their undoubted efficacy in combating fungoid diseases. The concluding chapters deal briefly with the fermentation of the grape, analysis of the wine, and the diseases to which it is liable. The book will be of great practical service to vine growers.

*Cours Élémentaire de Zoologie.* Par Remy Perrier. Pp. 734. 697 illustrations. (Paris: Masson et Cie., 1899.)

THIS work contains a great deal in brief that is to be found in its predecessor, the author's "Éléments d'Anatomie Comparée," published in 1893. In some respects it may be said to be a "Grundriss" to that volume, but, in contradistinction to it, the Vertebrata are here treated on a greater equality with the Invertebrata, and the order of presentation is more rational and in accordance with precedent. For example, the Chætopod

Worms are dealt with before the Arthropods, the inversion of this order being a notorious feature of the "Éléments." Chapter i. is devoted to broad principles and definitions, Chapter ii. to the elements of histology, and Chapter iii. to the classification of the metazoa—177 pp. in all. Tables of affinity and structural relationship are here and there given, and the 565 remaining pages of the work are devoted to a systematic consideration of each of the greater groups of animal forms in an ascending order, the Echinoderms, Rotifers, Polyzoa, and Brachiopods being taken after the Cœlenterates and before the Leeches and Worms. Some of the groups receive but scanty treatment, meagre and wholly insufficient, and throughout the work the author has conspicuously neglected the rendering clear the extremes of modification of the great groups, which we consider should be an indispensable feature of an elementary text-book on organic forms that shall do justice to our present knowledge. In dealing with such an assemblage as the Tunicata, where otoconia, valved, stalked, and many other well-known forms occur, a great opportunity has in this way been lost, and the same may be said of the author's treatment of the Bryozoa.

The illustrations are for the most part good and clear; some of the new ones are admirable, and we congratulate the author upon such as his aortic arch series (p. 602), which are the most accurate and up to date of any text-book set yet published. They are sure to be popular and reproduced *ad nauseam*. But why that old nightmare the Cuvier's "Chimæra" (Fig. 589), a badly drawn Chimæra with a Callorhynchus tail! Surely the time has come when this and other persistent atrocities of our text-books, which have so long offended, should be condemned.

A really sound elementary treatise on zoology has long been a desideratum, and the present work is the outcome of a commendable attempt to supply the need. Though desperately thin in parts it is up to date in its leading themes, well arranged, and written in a good easy style, and it may be safely recommended as trustworthy so far as it goes.

#### LETTERS TO THE EDITOR.

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#### Thermometric Scales for Meteorological Use.

In the course of some recent work on the meteorology of Ben Nevis, which involved extensive extracting and computing work, I have again had forcibly impressed on me the great advantage which Fahrenheit's thermometer has over that of Celsius for meteorological use, especially in temperate regions.

In chemistry and physics the range of temperature covered is so great that Celsius' scale, which is now universally used, adequately meets every case. The size of the degree and the change of sign at the melting point of ice do not cause any inconvenience in the laboratory. It is otherwise in the meteorological observatory. There the range of temperature dealt with is very restricted, and the Celsius degree is too large, while the change of sign in the middle of the working part of the scale is simply intolerable. The latter peculiarity is the fruitful introducer of error into both the observations and the reductions, and besides it greatly increases the fatigue of both classes of work.

In view of the agitation to abolish the use of Fahrenheit's scale, and to replace it universally by that of Celsius, it may not be inopportune to direct attention to some of the advantages in securing accuracy and in relieving labour which Fahrenheit's scale offers over that of Celsius when used for meteorological purposes.

In tropical countries it matters little whether one scale or the other is used, except that the size of Fahrenheit's degree is much